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THE UNIVERSITY OF ALBERTA

COMPUTERS IN SPECIAL EDUCATION

BY

KARL PETERSON

A THESIS

SUBMITTED TO THE

FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS

FOR THE

DEGREE OF MASTER OF EDUCATION

IN SPECIAL EDUCATION

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

FALL, 1988

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Computer Use with Special Needs Students", submitted by Karl Oliver Peterson in partial fulfilment of the requirements for the degree of Master of Education.

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ABSTRACT

The use of computers has expanded rapidly in recent years. A continuing problem has been to measure their efficacy in promoting learning. Empirical research has been used in attempting to measure the benefits of Computer Assisted Instruction (referred to as CAI) compared to Traditional Instruction (referred to as TI).

A comparison was first done with so-called normal students. The results proved to be equivocal because measures of achievement were sometimes positively related to computer instruction and sometimes not. The same situation resulted when empirical research was used to compare CAI to TI for special needs groups.

Development of computer use with special needs populations went ahead in two directions. First of all, many devices and programs were developed and used without an empirical demonstration that they were superior to TI or even that they were useful. Secondly, research studies began attempting to prove efficacy through pragmatic means - i.e. through the comments, attitudes and observations of practitioners and students.

The present study was based on a survey of teachers in Alberta who use computers with special needs students. An attempt was made to send a questionnaire to all of these teachers.

The questionnaire provided data regarding the groups of special needs students, the teachers' access to computers, the time the students spend with computers, the students' use of programs, the teachers' feelings about efficacy, and the teacher' attitudes towards computers in general.

The results of the study showed that teachers, students, and administrators were highly interested in this use of computers and that access to computers was not a problem. It was found that computers were used only an average of two hours a week for each student. Specific problems were revealed in the areas of teacher training in using computers, deciding how student learning with computers can be measured, and especially in the selection and classification of software.

It was concluded that there is room for both quantitative and qualitative research. Some specific recommendations were made on the basis of the literature review and the results of this study.

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Chapter I

Introduction

Information relating to computers and their use in education is expanding rapidly. Lieber & Semmel (1985) report that there are in excess of 150,000 microcomputers being used in the United States schools. Professional journals, commercial publishers and the popular media all agree that computer literacy is the survival skill of the 1990s.

Horn & Finn (1983) suggested that the group of students who will have the greatest opportunity to benefit from computer technology are the population identified as exceptional. Hanley (1984) reported that the number of microcomputers used for special education would increase 800% from 1982 to 1985 and that at the time his paper was written, about half the local special education programs in U.S. school districts used microcomputers.

This leads to the problem that is the central focus for this study. Basically stated, it takes the form of the question: How can one evaluate the effectiveness of computer assisted instruction with the students with special needs?

Special needs, in this context, refers to students who have the following difficulties: learning disablities, mental retardation, autism, emotional

disturbance, physical disabilities including (but not restricted to) cerebral palsy, paralysis, hearing impairments, visual impairments, and multiple combinations of the above. Each category will be considered separately on the assumption that computer assisted instruction will have different values and effects relating to the specific identified needs of the students.

The need for the present study centers around several factors. Probably the most important of these is to demonstrate the actual existance of an improvement in a special needs person's functioning that can be attributed to the use of a computer. This study accepts the possibility that such a relationship can be shown either qualitatively or quantitatively. The quantitative dimension refers to empirical proof that computer assisted instruction (referred to as CAI) has greater efficacy than teacher instruction (referred to as TI). The qualitative dimension is concerned with the improvement of quality of instruction by the use of the computers, although this may be based on opinion, utility and practical observation, rather than statistical verification.

Regardless of the usefullness of computers to persons with special needs, some caregivers, and administrators consider monetary expenditure of greater importance. Although the point at which utility

outweighs financial considerations exists only in each adjudicator's mind, this research will attempt to at least address the issue if not resolve it.

The question of attitudes is a rather moral and ethical issue i.e. teachers' opinions are self-valued. Practical observation suggests that research, as is contained in this study, may modify the thinking of some individuals working with persons with special needs. Points of view that need to be considered are, for example:

1. Computers are not really useful for persons with special needs, they are an expensive 'toy' because they can't be properly used.
2. Playing 'games' is the only really useful way for persons with special needs to use computers.
3. If computers are used, it will only be for 'drill and practice' to take pressure off the teacher.

Last, but not least, is the question of research directly involving computers in a curriculum for persons with special needs and that involving research as a goal in itself. It is important to know what new computer programs and peripheral devices are available to plan an adequate curriculum. Not only should this data be available but the efficacy of each device or procedure

should be considered. Even should this information not be immediately useful, it creates new banks of information and directs the course of educators and other professionals who are doing research not directly concerned with any given classrooms.

As stated by Elting (1982), the knowledge accumulated by practitioners in the schools must be documented and educators must establish contact with researchers. McBride (1987) emphasizes this point as she comments that waiting for efficacy studies to prove the value of computers before setting a policy direction is an abdication of responsibility.

Most of the data related to the use of computers with special needs students is derived from studies in the United States, not Canada. Therefore, one of the purposes of this study was to provide a data base which begins to represent Canadian students and to determine who is using computers and why.

Specifically, a questionnaire method was chosen to assess how teachers are using computers with special needs students in Alberta. The study was of a qualitative nature rather than quantitative. It is assumed that if a majority of teachers are finding computers useful, this presents a prima facie case for their continued and increased implementation as a learning device. Therefore, a variety of questions

relating to this issue have been included in the questionnaire.

If the teachers are not finding computers useful, then it is important to know why. Questions have been addressed to teachers in Alberta to determine if non-use might be linked to environmental variables, their own feelings and discoveries, or negative value related to happenings in the classroom.

The differing populations of special needs students may well determine the efficacy of computers, i.e. a computer might not be percieved to be as useful for a blind child as a child with learning disabilities. Therefore, teachers were questioned as to the utility of computers with specified groups of special needs students.

Furthermore, different uses can be made of computer programs. Some programs are more useful than others, consequently, teachers were asked to name some useful programs and how they used them - for example, for drill and practice, for games, or as a reward strategy.

Regardless of findings in Alberta, the use of computers with special needs students has become a controversial topic with both pros and cons. This is discussed in the following literature review.

Chapter II

Literature Review

Traditional Investigations of Microcomputer Effectiveness

Early empirical researchers contrasted the benefits of CAI (Computer Assisted Information) with standard, teacher-based, instructional delivery modes, e.g. Lieber & Semmel (1986), Semmel & Lieber (1985). Classically, the study of dependent variables focused on differentiating relative pupil academic gains, the relative efficiency of learning, and cost effectiveness of CAI applications for regular education students. Hence, CAI was viewed as a simple intervention variable to be compared with standard education treatments. A review of some studies based on this premise follows.

Visonhaler and Bass (1972) summarized the findings from 30 experiments that compared traditional instruction to traditional instruction supplemented by CAI at the elementary level. Traditional instruction (TI) is defined as the usual interaction of teachers and students along with the use of paper and pencil exercises. They concluded that TI supplemented by CAI was more effective than TI alone.

In a larger review, Jamison, Suppes & Wells (1974) concluded that no simple uniform conclusions can be

drawn about the effectivenss of CAI. At the elementary level, it appeared that CAI was effective as a supplement to regular instruction. At the secondary and college levels, they felt that CAI was a reasonably effective replacement for TI. This was based on an assumption which may be debatable, that older students do not need as much regular, face to face, contact with an instructor. Since no studies indicated CAI was actually inferior to traditional methods one could thus expect to save time and money by replacing the instruction with CAI in the case of mature pupils.

Edwards, Morton, Taylor, Weiss & Dusseldorf (1975) reviewed the findings in CAI literature. They commented that CAI was, in many cases, more effective for short term improvements but did not necessarily lead to long term gains - i.e. retention. When CAI was used as a replacement for TI, the overall results were equivocal - about half showed gains for CAI and half for TI.

The technique of meta-analysis was applied to CAI research beginning in 1977. Hanley (1984) describes meta-analytic reviews in that year, by Burns and Bozeman (1981), Kulik, Bangerts & Williams (1983) and by Kulik, Kulik, & Cohen (1980).

The most recent study, Kulik et al, (1983) was based on a meta-analysis of final examination results. CAI was given considerable credit, but there was a wide range of variability in the results reported.

In nine of 48 cases, the students receving TI performed better. The range of CAI impact was from a negative of 0.75 standard deviations, to a positive of 1.75 standard deviations. The standard error for the average effect size (0.32 S.D.) was 0.061. Thus at the 95% confidence level, the average effect size could range from 0.20 to 0.42 standard deviations. This is not really an impressive endorsement for CAI.

The research, as noted above, has led some educational researchers to question the value of further global research in determining the value of CAI. One of the notable spokesman for this group, was Clark (1983), who went so far as to say that the findings of a positive nature for CAI are confounded by faulty research designs, and especially the uncontrolled effects of instructional method and novelty.

In summary, the research as noted, seems to have been motivated by the belief that there was a simple relationship between the use of CAI and students improvement in school subjects. Accordingly, research designs were not carefully constructed to account for many possible variables, and indeed many of these variables may not have even been considered as existing. Most of the studies used experimental and control groups under treatment conditions. The measures of student achievement were usually such

straightforward criteria as student examination results. Internal and external validity appear to have been quite weak in the studies reported. One of the threats to validity is not describing the effect of subject-centered variables such as age, sex, and I.Q., or degree of handicap. Furthermore, the intervention situation may contain variables such as sensitization to the material presented or lack of quality, i.e. computer programs differ and are in themselves a variable novelty. Another problem is the "Hawthorne" effect, which refers to better performances simply because the subject is receiving attention. Unknown disruptive effects, e.g. - a noise, can also interfere. Last but not least, are experimenter effects, for example, personality interactions with subjects or failing to proceed in a standardized manner with each subject.

Research on CAI in Special Education

The methodology of empirical research regarding the effectiveness of CAI in special education has been of the same nature as that pertaining to education in general. However, Hanky (1984) reports that it is scant and that most of the studies in the field have been small and concentrated on substantively different applications with different handicapped populations. Nonetheless, representative samples are reported from

the literature as follows.

McDermott & Watkins (1983) investigated the effect of computerized instruction on students with special needs. Two hundred and five elementary pupils were assigned to a mathematics CAI treatment group, a spelling CAI treatment group or a conventional special education class. The investigators found that, upon administering a posttest after a year, the groups were essentially equal in achievement. Since the experimenters used a fairly large sample, (N=205), controlled for many variables by covariance, and conducted the study over a year's time span, it appears to have reasonable external validity. No generalization to other than learning disabled pupils could be made, however.

Lieber & Semmel (1986) paired learning disabled students and non-handicapped students to solve mathematics problems on a computer. Of twelve problems, the learning disabled children solved 6.89 problems correctly when working alone with the computer and 8.26 problems in a computer session working with a non-handicapped partner. Unfortunately, no one knows how many problems they would have solved working with paper and pencil or what personal variables, such as age, sex, or I.Q. were involved. Probably the most important findings was that statements made between subjects while they were

working, were positive in terms of self-evaluation.

McCaslin & Stevens (1984) reported a study on students with learning disabilities. An experimental and control group both showed more than two years deficiency in mathematics. When the experimental group received CAI as opposed to the control group receiving only instruction from a resource teacher, a number of findings positive to the CAI program were evident. For example, the experimental group gained twice as many skills and their average academic gain was 8 months, as compared to a mean of 3 months academic gain for the control group working with the resource teacher. While these results are impressive, it should be noted that these results are obtained on only 28 children. As well, one does not know what personal variables possessed by the children may have interfered, or what input the experimenters may have unwittingly introduced.

Chiang (1978) conducted a study of 200 students with learning disabilities in four elementary schools and four junior high schools. Experimental and control groups were chosen and lessons were given ranging from 17 minutes per week to 96 minutes per week over a period of 36 weeks. Eighty per cent of the students and teachers felt positive about the project. Although 75% of students in the CAI experimental group showed some gain on the posttest, only two

classes of Junior High students, out of six showed gains in the reading area, which were actually statistically significant. Unfortunately, it is somewhat misleading to say that 75% of the students made gains when it is admitted the gains are not significant. It would have been important to consider what personal or situational variables could influence only two classes.

Lally (1981) reported a study whereby mildly mentally handicapped students were divided into control and experimental groups to learn sight words. It is indicated that the group using CAI increased their recognition from 38 words to 70 words while the group receiving classroom instruction improved from 38 words to 47 words. A major weakness in this study was that no attempt was made to match the amount of teaching time between groups and thus the difference may not have been due to CAI.

A rather different study involved 77 hearing impaired children who were in a math course. This was done by Suppes, Fletcher, Zanorni, Horton & Searle (1973). A varying number of CAI lessons (i.e. 10, 30, 70, 100 & 300) were given to groups selected from the original population. It is reported that there was a significant relationship between the amount of time spent on the computer (i.e. number of lessons) and post test measures of academic

improvements. This, of course, is merely a measure of directionality and absolute magnitude of the improvement is not stated.

Fitzgerald, Fick & Millich (1986) compared the efficacy of CAI and TI with nine Elementary students identified as having attentional difficulties. The students were given groups of words to spell under CAI and paper and pencil practice conditions. The post test results indicated that CAI and paper and pencil practice, both significantly improved performance but that performance improvement was not really different between the two treatments. Since a single subject research design was used and 5 sessions were held to eliminate novelty and Hawthorne effects, validity was reasonably good.

Larson & Roberts (1986) attempted to discover if working with a computer would help the self esteem of students with special needs. After working with 5 randomly selected, special needs Junior High students, the authors indicated that a pretest, post test questionnaire did not clearly indicate changes but that personal observation did. However, when the experimental group were asked if others requested help from them (tutoring) in the use of the computer, 100% said "yes". When the group that received no experimenter computer interaction time were asked the same question, only 29% said "yes". This seems to

follow a trend that statistical comparisons of groups using CAI with non-CAI are often equivocal but that subjective questioning about the use of CAI yields positive answers.

A pilot study, completed by the researcher based on a replication of the work done by Kleinman, Humphrey & Lindsay (1981) attempted to explore the difference between CAI and paper and pencil math study using samples from the eduable mentally handicapped population in Edmonton and a nearby county (see attached data in Appendix A). The results were equivocal as has been the case in many of the studies previously cited. The pilot study was included in the present research, largely because the results were equivocal and thus further underscored the need for different research approaches.

Although there was a difference in the number of math questions completed per minute across subjects, Sample I (Edmonton) showed superior performance under paper and pencil conditions. Sample 2 (County) showed superior performance under CAI conditions. When accuracy was the criterion, there was no difference across subjects or samples.

Interestingly, the nature of CAI efficacy research with special populations appears to have been largely done with learning disabled students, which may be quite reasonable, since they constitute

the bulk of the special population (Hofmeister, 1983; Taymans & Malorf, 1984). The research tends to concentrate on drill and practice situations with experimental and control groups and analyzing significant differences between means of achievement scores. Mathematics is a popular subject area.

Research: A Descriptive View

Much research of a descriptive, non-inferential nature is also being done with special populations. In other words a number of educators are proceeding with new computer applications. These consist of describing learning and behavioral consequences of computer use without supplying statistical research data, to defend the efficacy of their work. Instead, they are concerned with educationally practical reactions on the part of students. Some examples of this type of research are noted below as they relate to two special populations - the visually impaired and the mentally and/or physically impaired.

Visually Impaired

The computer input process for the visually impaired depends on entering data into the computer by basically the same means as sighted users employ - i.e. the keyboard. However, certain modifications become very important. For example, Foulds (1982) states that there

have been over 100 modifications to communication devices. Each device has an input and output and some form of processing in between.

First of all, it would be theoretically possible to put braille labels on all of the keys. This method seems to have been replaced by other approaches. As Sowokinos (1986) states all keys were not labeled in her project because labels come loose, they interfere with learned typing skills, and keys can be voiced as they are pressed. Instead, felt dots were used on "F" and "T" keys to give a point of reference and also were placed on several end keys which are the normal limit to the extent of the keyboard when touch typing. Certain keys, functional only on a computer, such as reset, return, escape, etc. were braille labelled.

Another suggestion, made by Goodrich (1984) is a device to "freeze" all keys except six (and the space bar) which corresponds to a Perkins brailler configuration. This would allow dual use of the keyboard. The Perkins Brailler is a six keyed device that resembles a typewriter and produces braille dots.

One of the most useful input devices is the VersaBrailler as described by Doorlag & Doorlag (1983). The unit has a keyboard and spacebar (again similar to the Perkins Brailler). It is actually a computer which uses an audio cassette to store up to 400,000 characters. This is equivalent to about 400 pages of braille

information.

Goodrich (1984) stated that visually handicapped individuals gain information from computers in five ways. Voice synthesizers are attached to the computer so students hear the information on programs or hear a voice sound depending on what key is pressed. Refreshable (i.e. changeable) braille is the output from the VersaBrailler as described above. Hard copy braille can be produced on paper by the same method as is used for any computer printout. Low vision aids simply involve using magnifying devices or telescopes to see the computer or its output. Large print can be produced on the monitor screen or by the use of special programs. For a list of the advantages and disadvantages see Goodrich (1984).

Mentally and Physically Handicapped

A number of input methods are available for those individuals who might have handicaps in addition to the visual area. Considerable attention has been paid to the physical area - for example, students who might have cerebral palsy. Some of the adaptations can doubtless also be used for those who are diagnosed as mentally retarded or emotionally disturbed.

Foulds (1982) indicated that a computer can be operated as long as some part of the body is mobile.

Thus, computers are being operated with a stick held in the mouth, fastened to the head or held with the feet. Work is being done with computers that can be operated by voice recognition or eye movements. Bennet (1982) described a system whereby the individual can make the computer react by touching the viewing screen.

Brinker and Lewis (1982) suggested an input system which would be useful to all types of handicapped children. They referred to it as the contingency intervention system. This is not a new idea in that it is based on the premise that handicapped children should be rewarded for movements that show an attempt to react to, or control the environment. However, in their experiment the microcomputer has removed the slow and tedious process of providing consequences for responses, and counting responses, from parents and teachers. Instead, the computer accepted even a chance movement of an arm or leg (up to eight possible inputs) and responded with at least eight different outputs - eg. music. At the same time, it kept track of speed and intensity of responses.

Bennett (1982) described a program for the mentally handicapped and visually impaired. It presented the student with stimulus pictures on a

TV monitor screen accompanied by verbal commands such as "touch the nickel". The student responded and the program sensed where the screen was touched and classified the response as correct or incorrect. The system has been used for telling time, matching shape, size and color and recognition of simple words.

In general terms, what might be referred to as "rehabilitation technology" has met the needs of special needs students in five ways: communication aids interfaced to a computer, microswitches, a methodology of anatomical fitting of switches and controls, expansion of the use of single switches and communication boards, and delimitation or reinforcers to aid in the teaching of persons with severe disabilities (Flanagan, 1982).

Flanagan (1982) described several devices which can be used as comminication aids by non-vocal individuals. Two of these, the Autocom and the Express III, can be interfaced to a computer with the aid of an emulator. The input signals originate from the communication device and the emulator modifies them to the form of signals which would be the same as those which would emitted from a computer keyboard. Thus, the person who cannot communicate normally can readily use a computer.

The use of switches as a replacement for sophisticated electronic aids is also described by

Flanagan (1982). Thus individuals who are just developing pre-communication skills can, through technologically adapted switches, operate toys, light boxes, tape recorders and other common output devices. Flanagan (1982) mentions four types of switches:

1. A tread switch like a sewing machine pedal which can provide auditory feedback.
2. A lever switch, i.e. a foam pad on a long lever arm.
3. Arm slot control, i.e. a series of single switches in linear array which can be activated by gross arm movements.
4. A two choice light indicator which can begin descrimination training or teach "yes" "no".

Flanagan (1982) also describes a methodology of fitting and application of switches and controls, to the body. The basic procedure is to determine:

1. An anatomical control site (foot, hand, etc.).
2. The optimal control.
3. A control position.
4. A control mounting system.

Until recently the ability of individuals

using a communication board or switches to access a computer was quite limited. However, Flanagan (1982) describes two new developments which have alleviated the problem. One is the Adaptive Firmware Card which enables a single switch user to access standard computer software. The other is a Unicorn Board, which consists of a matrix of squares which are programmable by the user. The actual display seen by the user can consist of a series of squares with letters, words or pictures or one large symbol covering the entire board.

Aside from the use of aids to access the computer some consideration must be given to sensory reinforcers which can be generated by a computer and which are suitable for the training of severely disabled individuals. Datillon (1987) described these in three categories. The most effective visual reinforcers have been found to be color motion picture film, strobe flashes, windshield washers, general illumination of a room, and colored lights and color television. The most effective auditory reinforcer appeared to be music. The most effective tactile reinforcer is reported to be vibratory stimulation. Thus, the combined data on sensory reinforcement has led to the development of a computerized instrument that allows differential selection of preferences between sensory activities.

In summary, it appeared that many groups of special needs students are receiving some sort of CAI. Although the efficacy of the procedures cannot consistently be empirically demonstrated, field research and improvement of facilities continues unabated.

Evaluation of Software

It thus appeared reasonable that each segment of the handicapped population should be investigated using as rigorous research techniques as possible. One of the greatest weaknesses in present studies seem to be in the non-control of independent variables which confound the claimed relationship of the independent variable under study (i.e. CAI) and the dependent variable (i.e. some change in school performance).

One variable is software. Hofmeister (1985) states that poorly written products confuse the naive user, anger the sophisticated user, and embarrass the authors as they become more skilled in CAI development. As rightly pointed out, if the programs have no validity, obviously no positive change will take place in the students using them.

To underline the magnitude of the problem, Horn & Finn (1983) state that there are about 400

software producers in the United States. There is some help available for school personnel in considering the purchase of educational courseware. For example, if one subjects the material to the analysis procedure suggested by Bennett (1985), few problems can go without notice. He suggests that a 13 question analysis be applied to all pieces of software.

The first question is related to consistency with curricular goals, specifically the IEP. A list of student goals might be constructed and then the courseware under review should be examined to discover what educational goals it appears to facilitate. If a poor match between courseware content and pupil IEPs is found, there can be little justification for a purchase.

Bennett (1985) goes on to query if there is any evidence to support the effectiveness of the product. Often there are problems in this area due to cost of evaluation studies, lack of in-house research expertise and the delay which would be involved in evaluating a product before it could be brought to market.

A product might also be checked to see if it incorporates sound learning principles. Although there is still room for debate, several principles of learning have been identified. One example is to provide frequent corrective feedback. Another is to provide a variety of instructional techniques, for instance, a program could provide both text and graphic explanations. A third

principle is to maximize the motivation. Finally, an attempt should be made to cater to different initial levels of achievement and rates of progress of students so that boredom and frustration can be avoided.

The user should be aware of possible factual inaccuracies, ungramatical text and misspellings. In the same category, there are sometimes stereotypic or misleading representations of people, for example, a minority group.

The possible value lessons involved in the communication process of the product, should be considered even if the value taught is very subtle. For example, shooting down aliens is a very common motivational technique in programs. Some members of the public would state this technique promotes violence.

Attractiveness of the courseware should be questioned. This involves color, graphics, animation and sound. Interestingly enough, it is suggested that too much motivation - i.e.color, sound - may distract the student from the central task. Indeed, too much stimulation results in seizures in certain elements of the special education population.

A user should consider the unique capabilities of a computer when looking for software. Many programs are simplistic, offering little more than drill and practice which could be provided by a television or a radio. The computer can modify large amounts of information,

maintain a student progress record or offer simulations, all at the same time and good programs make use of these capabilities.

The physical and cognitive requirements of the courseware should match student abilities. Many special students cannot interact with the computer because of physical limitations and therefore, programs must be designed incorporating the possible use of special equipment - i.e. keyboard modifications. At the same time, it must be realized that programs presenting directions or exercises beyond a special student's reading level, are useless.

Programs should be what Bennett calls 'user friendly'. This refers to the ease with which a program can be run, assuming no expertise in the use of computers. It also involves what McCaslin & Stevens (1984) call "shell programs". These are set up to allow the teacher or even the student, to add new content or modify the old.

The user should beware of programs that have little or no documentation with them. Proper documentation states the goals of the program, capabilities students are expected to have, the need of any accompanying materials or hardware options and technical data such as "how to use error messages".

If technical support from the publisher cannot

be obtained, the user should question the program. Almost any courseware may raise questions in the user's mind or may present "running" problems. A good publisher will stand behind their product, for example, have a toll free telephone number or suggest a dealer to contact.

Some programs are restricted in the manner in which they may be used. For example, the program may be 'locked' and cannot be copied for use with several students. The policy of the publisher should be considered carefully in order to avoid additional expenditure after a program is purchased.

Lastly, the same programs do not run on all computers. Some are more universal than others. The program usually states, (or should state), the brand name of computers for which it is suitable.

An even more exacting method of analyzing computer software is detailed by Sitko (1985). He supplied a rating form of 70 items to assess any computer software package by technical qualities, curricular considerations and psychological considerations. The evaluator gives a software package a rating of "2" if it is very appropriate for a given consideration; a "1" if it is fairly appropriate; and a "0" if if is inappropriate. If an item of software is given a "1" or "0", then it is re-ranked as "2", if a student or teacher can modify

the program. It is given a "1" if it can be modified by support personnel in the school system. But, if the item can only be modified outside the system, it is given a "0".

After ranking the software program on all dimensions, a Composite Software Suitability Score (CSSS) is calculated by the following formula:

$$CSSS = \frac{2(TRSDA) + TRSMP}{N}$$

TRSDA is the total rank score for degree of appropriateness and it is multiplied by 2 to show that it is more important than TRSMP (total rank score for modification potential). 'N' is the actual number of rankings, since some considerations may not have been applicable to a certain software package.

Some teachers may feel that subjecting programs to all of the questions and criteria outlined previously, may be too time consuming and tedious. They need only try to run one frustrating program to appreciate the value of being prepared well in advance. Also, in a time of fiscal restraint, such as now being experienced, it must be remembered that computer programs cost a minimum of $50 each. The luxury of trying out a program and then letting it sit on library shelves, is one that can no longer be enjoyed.

As a final comment, the one problem that appeared most often in special education software programs is a

mismatch between the instructions and content of the program, and the students' comprehension level. Programmers often attempt to make the content of their work very simple, but if they do not understand what causes reading and comprehension difficulties, the work will grind to a halt on some key word. It cannot be overemphasized as a warning to teachers that what a student cannot understand, he cannot do, no matter how interesting the material appears.

Need For a Fresh Approach

Empirical results have been equivocal regarding the usefulness of computers on studies relative to the special population. It thus appeared reasonable that a fresh approach should be used to generate data related to the use of computers with special needs students. Of the previously cited studies, one of the greatest weaknesses seemed to be in the non-control of independent variables which confounded the claimed relationship of the independent variable under study (i.e. CAI) and the dependent variable (i.e. some change in school performance).

Even the exacting method of using a single subject research design as explained by Baumgart & VanWalleghem (1987) failed to produce other than equivocal results. These investigators compared three moderately mentally retarded subjects to themselves on the criterion of

learning words related to groceries under CAI and TI conditions. Multiple probes and alternating treatments showed that two subjects learned well in either situation and the third learned only in the teacher taught situation.

Mokrus & Russel (1986) provided what appeared to be the only article available for the present review that emphasizes a new approach. They have analyzed the dependent variable from a teacher centered point of view using a survey instrument. Their interest was in discovering to what extent special educators are using, or moving beyond, drill and practice software, and also to what extent these educators are being helped or hindered in their practices. They used a telephone survey to sample the responses of teachers in fifty school districts. However, only 33 teachers were eventually interviewed. A majority of the teachers worked with learning disabled students and other conditions mentioned were emotional disturbances and mental retardation.

The work of Mokrus and Russel (1986) provides a framework for the research in this study. It is felt that, by extending their research, both in number of questions and sample size, valuable information can be gathered regarding use of computers with special needs students.

Furthermore, the literature review in general,

leads to several conclusions which provide a rationale for this study:

1. Efficacy of CAI is difficult to measure empirically and might well be measured through evaluation of involved personnel.
2. The existance of computer use with all groups of special needs students is reported in the literature but the quantity and quality of implementation locally needs to be investigated. Reasons for use and non-use should be investigated.
3. Drill and practice is perhaps the most popular reported use of CAI but perhaps not the most effective. School personnel should report their uses of CAI.
4. Selection and development of programs is reported as a serious problem. Input from school personnel regarding this point is therefore very important.

All of the above were addressed in the formatting of the survey questions and in the analysis of data that follows.

The study was focussed on measuring the efficacy of computer use with special needs students as seen by educational personnel. It was concerned with identifying

programs and their use. Teacher attitudes about computers and their general feelings about computers and computer research formed a final focus.

Chapter III

Methods & Procedures

The present study sampled computer use by special needs students in school districts of Alberta. This was done by administering a questionnaire (see Appendix B) based on a revision and expansion of the questions asked by Mokrus & Russel (1986). The purpose of the questionnaire was:

1. To provide new directions in research for special needs students using computers.
2. To gain data for making practical suggestions to teachers and administrators regarding computer use by special needs students.
3. To determine "state of the art" uses of computers by special needs students of Alberta.

The Sample

The literature on the use of computers mentions intervention with a variety of special needs groups. Accordingly, this study attempts to provide information relating to the use of computers with

students in the following categories: trainable, educable, severely or profoundly mentally handicapped; learning disabled; autistic; emotionally disturbed; physically disabled by cerebral palsy, paralysis or other trauma; deaf or hearing impaired; blind or visually impaired; combined vision and hearing problems; and multiply handicapped. The definitions of these terms are based on their occurance in special needs funding criteria and on teacher perceptions of the groups.

An important delimitation was age of the sample group. It is recognized that even young children and many adults can benefit from use of computers, but Mokrus & Russel (1986) focussed their questions on school age children (defined as approximately age 6 - 18 yrs), so this research will follow that lead. In further support of this point of view, it has been noted that most of the research literature describes public school situations.

In order to discover how teachers were using computers with each of these groups, a questionnaire was sent to school systems in Alberta. Specific administration of the questionnaire was based on the following steps:

1. A list of school jurisdictions with approximately 100 teachers or more were identified from the List of Operating Schools in Alberta.

2. The superintendents of these jurisdictions were contacted and asked to identify schools which educate special needs pupils (defined as those who would be eligible for a special educational grant). (See letter Appendix C-1). The superintendents were asked to contact principals in these schools and have the principals identify teachers who were directly responsible for the education of special needs students. The principles were asked to complete a form letter and return it to the reseacher in a stamped, addressed envelope. (See Appendix C-2).

3. Teachers identified in step 2 were mailed a questionnaire to be described in the next section. They were requested to fill out the questionnaire within a week and return it in a stamped addressed envelope to the researcher. (See letter Appendix C-3).

The Instrument

A questionnaire format was used in the study because of the size of the potential sample of respondents. A total of 383 questionnaires was sent out. Due to time and cost factors, telephone interviews (such as those described by Mokrum and Russel 1986), and personal interviews, were

not used. Fowler (1988) suggested that 30% is a very minimum response rate for questionnaires and 50% was set as an arbitrary standard for this study. If the return rate was below 50%, follow-up telephone calls would have taken place in order to increase the return rate to 50%. The actual return rate was 52% making this contingency unnecessary.

The first step in constructing the questionnaire was to consider the questions asked my Mokrus and Russel (1986). The investigator drafted a set of questions based on the research in Mokrus and Russel's (1986) study and added a variety of questions germane to the purpose of the research. University of Alberta and Edmonton Public School Board personnel were consulted in wording the questions. After the questionnaire was completed, it was "piloted" on several teachers who generally indicated they felt the questionnaire was pertinent to the situation and readily comprehensible. A copy of the questionnaire is included in Appendix B.

Specifically, the questionnaire first required teachers to define whether they were in a large or small school system (Section A-1). While it was not the goal of this research to compare groups of teachers, it was felt that size of system might

be a variable effecting computer use and comments or conclusions could not have validity if various systems were not represented.

The possibility of access to computers was felt to be of primary importance. Therefore, teachers were asked if they had access to computers in the school and also in their classroom (Section A-2, A-3).

Perhaps more important than simple access, was the question of how often teachers used computers and whether they felt the access was sufficient. A question about the types of computers used and why these computers were selected was included (Section A-4, A-5). It was felt that the answers might relate to teacher and pupil satisfaction such as cost and program availability.

The sampling of special needs students was very important to the study and therefore, the teachers were asked to identify the numbers of students they dealt with in twelve classifications (Section B-1). It was decided not to provide specific definitions of students but relate these definitions to special needs funding classifications.

Once the categories of special needs students had been identified, it was necessary to determine if all categories of students used computers and

how many hours per week (Section B-2). A question to determine the most useful purposes of computers with the special needs groups was also included (Section B-3).

The question of selecting computer programs for special needs students received significant consideration in the literature, (eg. Hofmeister, 1985). Therefore, teachers were asked to name the programs in common use and to indicate whether the programs were useful for drill and practice, improving motivation and self-esteem, playing games, supplying rewards, prompting computer literacy, or developing word processing skills (Section B-4). Although the question as to who published the materials was not included, many teachers were thoughtful enough to supply this information.

Another variable to be probed, was the teachers personal feelings towards computers. Thus, they were asked whether they were comfortable or uncomfortable using computers, what type of training they had in computer use, whether computers helped them teach, and whether the students appeared to learn more and better and appeared to derive satisfaction from computer use (Section C-1 to C-4). Open ended questions such as "Why?" or "How?" provided much information related to the teachers' attitudes.

For any teachers who did not use computers and for a further general sampling of attitudes, it was necessary to probe negative feelings toward computers and difficulties in computer use. Thus, teachers were asked if there were inappropriate programs and equipment; if computers were not considered generally useful for special needs; if time was lacking; if students showed negative attitudes; or if administators tried to resist computer use and computers were thought to be too expensive (Section D). An open ended category of difficulty in computer use brought a few responses.

Lastly, teachers were invited to make any comments on the need for research in the use of computers with special needs students.

Data Analysis

A great deal of data was obtained from the answers to the above noted questions. Much of it is reported as percentages because of the questionnaire format and the exploratory nature of the research.

Thus, tables were developed to show the number of teachers having access to given numbers of computers, the frequency of access to computers and the brands of computers used. Reasons for choosing the computer(s) are reported in percentages. A table is shown which

reports the number of teachers who are responsible for each category of special needs students and it should be noted that many teachers have multiple assignments. Tables are provided showing the numbers of computer hours for each category of students and a mean is shown for each group. A variety of tables summarize teacher feelings about computers, for example - the effectiveness of computers and computer programs, categories of groups using the programs, the affective reactions of teachers and students and opinions about teaching effectiveness of computers. A table of present and potential difficulties as teachers perceive them is included. Several of the questions which required a "why" or "how" response generated lists of teacher opinions. A final table identifies a list of research areas which teachers see as important.

All of the above tables are presented in detail and summarized in Chapter Four. The total number of tables is twelve.

Chapter IV

Results

Seventy-seven school systems were contacted. Sixty-eight superintendents or 88% responded favorably and gave permission for their jurisdictions to participate in the study.

Three hundred and eighty-three questionnaires were forwarded to teachers. Two hundred and ten were returned. Two hundred had useful data, although not all teachers completed all items. Ten questionnaires were returned blank or as refusals. Thus, the return rate of the useable questionnaires was 52%.

General (Section A)

Of the teachers responding positively, 39% (77), worked in school systems employing 200 or more teachers, and 59% (118) were employed in systems with less than 200 teachers. Five teachers did not indicate the size of their system.

The number of teachers having access to a computer or computers in their school was 98% (196). Only three teachers reported no access to a computer and one teacher did not answer the question. When teachers were asked if they had a computer in their classroom, 69% (137) said "yes" and 31% (63) said "no".

Specific comments and tables relating to

questionnaire responses are indicated in the pages to follow. Non-responses are indicated as part of percentages. Topics dealt with were special needs groups, computer times, use of programs, the efficacy question, teachers' feelings about computers including brands of computers, and directions for future research.

Special Needs Groups (Section B-1)

Special needs groups are represented as percentages of the total sample in Table I.

Insert Table I about here.

Mental Retardation was the largest category at 36%, with Learning Disabled the next largest at 31.5%. Physical Disabilities formed 16.5% of the sample. Other categories such as Autistic, Multiple Handicapped, Deaf or Hearing impaired and Blind or Visually Impaired, comprised less than 5% of the total.

Out of the 200 teachers, it was determined that 13% (26) had only mentally handicapped students in their classrooms and 30% (59) had only learning disabled students in their classrooms. Twenty-six percent (51) dealt with students representing two major handicaps, (as represented in Question B-2); 17% (34) had dealt with students representing three handicaps, 6% (12)

Table I

Special Needs Groups Sampled

Group		% of Sample
Mental Retardation		36.0% (148)
Educable	56.0% (44)	
Trainable MR	30.0% (83)	
Severe, Profound	8.0% (12)	
Not Specified	6.0% (9)	
Learning Disabled		31.5% (131)
Autistic		4.5% (20)
Physical Disabilities		16.5% (67)
Cerebral Palsy	57.0% (38)	
Paralysis	13.0% (9)	
Other (Spina Bifida, Muscular Dystrophy, Malformation, Epileptic)	22.5% (15)	
Not Specified	7.5% (5)	
Multiple Handicaps		3.0% (14)
Deaf of Hearing Imparied		4.0% (16)
Blind or Visually Imparied		4.5% (20)
		(416)

dealt with students representing four handicaps, and 2% (3) dealt with students representing five handicaps. Three percent (5) of the teachers dealt with Multiple Handicapped, Deaf or Hearing Impaired, Blind or Visually Impaired and Physically Disabled. The remaining 3% was undetermined.

Computer Times (Section A-2, A-3, A-6, A-7, B-2)

These sections address the number of teachers who had access to particular numbers of computers; how frequently they accessed these computers; and the number of hours per week each group of special needs students used computers.

Results of Question A-6 indicate that 34% had access to one computer, 21% had access to 2-4 computers, 10% had access to 5-9 computers, and 14% had access to 10-13 computers. It should be noted that these figures do not take into consideration whether the access was in a "home room" or elsewhere in the school. Twenty per cent of teachers had access to 15 or more computers and this occurred in a computer room.

Table II shows the frequency of access to computers.

Insert Table II about here.

The table shows an increasing quanitity of amounts of time from rarely to anytime, daily or as required. The expressions "daily", "anytime" and "as required"

Table II

Frequency of Access to Computers

Time	% of Teachers
Rarely	1.0%
Rotation schedule ranges from 3 months to 6 months	2.5%
One x per week	10.0%
Two x per week	5.5%
Three x per week	5.5%
Four x per week	1.5%
Eight x per week	0.5%
Fourteen x per week	0.5%
Twenty x per week	0.5%
Anytime	35.0%
Daily	25.5%
As required	12.0%

are categories creasted by the respondents and not dictated by the questionnaire.

The majority (72%) reported that they had access to computers "anytime", "daily" or "as required". Three percent said they had access to computers from 4 to 20 periods per week. Twenty-one percent reported they could use computers 1 to 3 times per week; 2.5% reported access to computers on rotation basis i.e. part of year. One percent said they "rarely" had access to computers.

The mean number of hours teachers used the computer with each of the special needs groups previously identified is shown in Table III. Each group of special needs students is listed along with the mean number of hours per week the teachers use the computer as a medium of instruction. The range of hours per week was from 1.2 to 2.4 indicating little variation in hours as a function of special needs groups. The overall mean was 1.9 hours per week.

Insert Table III about here.

Table III

Computer Hours Per Week

Group	Hours/Week	
Mentally Handicapped		$\bar{x}$ = 1.7
EMR	$\bar{x}$ = 2.01	
TMR	$\bar{x}$ = 1.90	
Severe and Profound	$\bar{x}$ = 1.20	
Learning Disabled		$\bar{x}$ = 1.90
Autistic		$\bar{x}$ = 1.90
Emotionally Disturbed		$\bar{x}$ = 2.30
Physically Handicapped		$\bar{x}$ = 1.97
Cerebral Palsy	$\bar{x}$ = 2.40	
Paralysis	$\bar{x}$ = 2.00	
Miscellaneous Physical Disabilities (Spina Bifida, Muscular Dystropy, Malformation, Epileptic)	$\bar{x}$ = 1.50	
Deaf and Hearing Impaired		$\bar{x}$ = 2.00
Blind and Visually Impaired		$\bar{x}$ = 2.00
Multiple Handicaps		$\bar{x}$ = 1.60
Overall Mean		1.90
Overall Range		1/2 - 6

Use of Programs (Section B-3, B-4)

Teachers were asked two questions specifically relating to the use of programs. They were asked to indicate how they used the computers (purpose) and how effective the computers were in accomplishing this. The general uses were to be classified on a "1" to "5" scale from least effective to most effective. The reader might note that the questionnaire shows "5" at the "ineffective" end of the scale but when the data was analyzed, "1" was used to represent "least effective" and "5" was used to represent "most effective". The results are shown in Table IV.

Insert Table IV about here.

Drill and practice was the most popular use, followed by improvement of motivation and self esteem. Games was next, followed by word processing and general reward. Computer literacy was the lowest.

In regard to effectiveness (B-3), Drill and Practice and General Reward were considered to have the highest value (above 70% in "most" effective category). Improved Motivation and Self Esteem (69%), Word Processing (64%), and Games (63%) were also viewed as relatively highly effective. Computer Literacy was rated at moderately effective (55%).

Table IV

Use of Programs & Effectiveness

Use Chosen	%	% of Effectiveness Least				Most
Drill & Practice	25%	1%	10%	19%	33%	37%
Improve Motivation & Self Esteem	18	5	8	18	32	37
Games	17	3	10	24	28	35
General Reward	15	1	7	20	28	44
Word Processing	15	8	1	27	23	41
Computer Literacy	10	10	2	33	31	24
Total	100%					

Since having students who are heterogeneously grouped is a different situtation than having a homogeneous grouping (eg. learning disabilities), some consideration was given to how the teachers in different situations might use computers in a different way. Teachers were grouped in three categories: those with learning disabled students, those with mentally handicapped students and those with students representing various handicaps. No difference was apparent on any of the questions except question B-3 which attempted to ascertain the use of programs. The results are shown in Table V.

Insert Table V about here.

There appears to be a difference as the table shows varied use of programs for the three groups. The teachers having only one type of student to deal with report similar frequency of use for the purpose of drill and practice, improving motivation, and games. In three of the six categories, the teachers with heterogeneous groups differed from both other categories in their choice of program use. There were no similarities in the use for general reward and word processing for the three groups. The "various conditions" group was considerably higher in word processing than the other groups.

Table V

Categories of Groups Using Programs

Legend: D&P - Drill and Practice
GR - General Reward
IM - Improve Motivation and Self Esteem
CL - Computer Literacy
G - Games
WP - Word Processing

Category	% Choosing Program Use					
	D&P	IM	G	GR	CL	WP
Learning Disabled (N=59)	84	66	55	45	25	36
Various Conditions (N=85)	100	84	64	69	42	58
Mentally Handicapped (N=56)	85	69	53	57	43	46

The question (B-4) asking for a list of names of programs and uses to which they could be put, generated a list of 289 programs. This list and uses of each item are included in Appendix D. Many of the programs were used by only a few teachers. The top five program series were: MECC (all series), Milikin Math, Bank Street Writer, Sticky Bears Series, and Fays's Series. Publishers are included in the list where teachers supplied them.

When the uses to which the programs could be put were tabulated, most teachers indicated a general use (36%). The remainder were drill and practice (29%), improved motivation (16%), games (7%), general reward (6%), computer literacy (2%), and word processing (4%).

The Milikin Math Series and Elementary Pre-Reading and Counting, were the top programs in the General category. Clock Works, Circus Math and Friendly Computer, were top progams in the Drill and Practice category. Milikin Math, Circus Math and Cross Country Canada, were top programs in the Improving Motivation category. Circus Math and Spell It were the only programs receiving any significant number of choices, under games. Spell It was the relatively highly mentioned program under General Reward. Apple Works and Friendly Computer were the highest ranking programs under Computer Literacy. Apple Works and Bank Street

Writer were tied for top position in Word Processing.

Efficacy (Section C-3, C-4, C-5)

Several questions related to efficacy i.e. how useful computers, rather than programs, really are to teachers. Initially, teachers were asked to rate computers as to their use in teaching on a "1" to "5" scale. The reader might note that the questionnaire shows "5" at the "ineffective" end of the scale, but when the data was analyzed, "1" was used to represent "least effective" and "5" was used to represent "most effective". Ninety per cent rated them as moderately to very useful i.e. being between the midpoint to the top of the scale. Only 10% reported computers were ineffective as teaching tools.

When teachers were asked how computers were useful for teaching, they supplied the list shown in Table VI.

Insert Table VI about here.

Motivation, reward and reinforcement were the most important reasons given at 26.5% and 21.5%. Use for drill and practice was next at 19.5%. Individualization was mentioned by 10% of teachers. Providing new experiences and teaching specific skills were mentioned less frequently (under 10%). It was interesting that, although some teachers saw computers as ineffective, no negative comments were offered.

Table VI

Reasons for Usefulness in Teaching

Teachers' Suggested Reason	Frequency
Motivates	26.5%
Rewards and Reinforcers	21.5%
Drill and Practice	19.5%
Individualization	10.5%
Provides New Experience	7.0%
Teaches a Specific Skill	6.5%
Word Processing	4.5%
Improves Hand/Eye Co-ordination	2.5%
For Games	1.5%
Total	100.0%

*Note: No negative reasons specified.

Another question (C-4) asked teachers to classify the use of computers according to whether students learn "more and better" or not. They were also allowed to indicate uncertainty with a "not sure" category. The "more/better" category was chosen by 53% of teachers, "not sure" by 33%, and the "negative" by 6%. The question was not answered by 8% of the teachers.

When reasons were requested for this view of student learning, more than half of the respondents mentioned motivation (53%) and reinforcement (20%) was another top reason. Fun was selected by 14.5% and a "new approach" and "use for word processing" chosen by under 10%.

Their comment that learning "more and better" can't be measured was by far the leading negative response at 56% of total responses. This was followed by "depends on individual" by 17.7%, poor programs at 13% and "limited transfer" and "untrained teachers" at under 10%.

A question (C-5) in this series, asked teachers to dichotomize the use of computers as creating much student satisfaction or little student satisfaction. Teachers overwhelmingly endorsed the positive view at 90% (181) and 4% (6) chose the negative view. Of this, 14% (5) individuals attempted to select an uncertain category by writing in "only some satisfaction". Thirteen teachers did not answer the questions.

Table VII show reasons for satisfaction.

Insert Table VII about here.

On the positive side, enjoyment and motivation dominate at 44% and 21% respectively. Those who picked "little satisfaction" commented that it "depends upon the individual" 61% with the greatest frequency. This is of some dubious significance, since negative comments relating to this question were found only on 9% (18) of the questionnaires. This was an open ended question and only 40.5% of teachers made a comment.

Feelings and Attitudes

This section examined teachers' opinions and their perceptions of facts where there was not a direct relation to pupil attitude or achievement. In short, the responses showed variables that may be significant in the use of computers and were germane to the teachers themselves.

When asked what brand of computers they were using teachers endorsed the "Apple Products" at 91%. I.B.M., Commodore, Radio Shack and Apple clones (not manufactured by Apple Company) were otherwise mentioned with close to equal frequencies. A specific breakdown of the brand names is shown in Table VIII.

Table VII

Student Satisfaction

Positive Comments	% N=63	Negative Comments	% N=18
Enjoyment	44.0%	Depends Upon Individual	61.0%
Motivation	21.0%	Only Some Satisfaction	28.0%
Reward	12.0%	Becomes Boring	11.0%
Immediate Feedback	8.0%		
Novelty	8.0%		
Improves Self Esteem	3.5%		
Reinforcement	3.5%		
Total	100.0%		100.0%

Insert Table VIII about here.

An enquiry was made as to why certain brands had been selected. Teacher's reported reasons are shown in Table IX. The leading factor was found to be software availability at 24%. Other highly valued reasons were Local Administrative decision (17.5%), cost factor (12.0%), recommended by Dept. of Education (8.0%), and already there (7.5%). It is important to note that their was no response by 14.5% of teachers.

Insert Table IX about here.

Teachers were asked to describe their training in the use of computers. Since they could pick more than one category, or add categories, the results do not indicate if any categories are the only means of furthering their learning skills. In any case, "self taught" was the leading category at 32%, followed by "general workshops" and "help from colleagues", each at 25%. Having taken post secondary courses, and inservice for special education teachers, were lower at 8% and 7% respectively.

A question as to whether they felt comfortable or uncomfortable with computers was put to teachers.

Table VIII

Computer Brand Reported

Brand	% of Teachers Reported
Apple IIe	55.0%
Apple	16.0%
Apple IIc	7.5%
Apple IIg	6.0%
Apple II	5.0%
Commodore	3.5%
IBM	3.5%
Apple Compatible	1.5%
MacIntosh	1.0%
Radio Shack	1.0%

Table IX

Reason for Choice of Computer

Responses	% of teachers
Software factor - i.e. availability	24.0%
Local (Board Level) Administrative decision	17.5%
Cost factor	12.0%
Recommended by Dept. of Education	8.0%
Already there	7.5%
Received from another school/class	4.0%
Newest available	3.5%
No idea	2.5%
Best suited needs and requirements	2.0%
Popularity of Brand	2.0%
Used in business	1.5%
Easy to operate	1.0%
*No response	14.5%

They were allowed to respond on a '1' to '5' scale. Moderate (mid point on the scale) to high comfort was expressed by 88% of the teachers. About 9% felt discomfort and 7 individuals did not answer the question.

About 40% of the teachers offered reasons for their attitudes. An equal number of positive and negative reasons (40 individuals each) were indicated which is surprising in view of the initial high "comfortable" response. The major positive reason was "easy to use" at 42% and the major negative reason related to "lack of knowledge" at about 79% of the responses.

The teachers were asked what they perceived as possible difficulty or obstructions in their use of computers. The results are shown in Table X.

Insert Table X about here.

By far the leading problem was inappropriate programs at 40% of the responses. "Too expensive" was mentioned at 21% and "not enough class time" was given at 20%.

A final question on the survey requested teachers to write in topics or methods they would like to see employed in further research on computers and special needs students. The results are shown in

Table X

Difficulties in Using Computers

Difficulty	% of Teachers Reporting
Inappropriate programs	40.0% (132)
Too expensive	21.0% (69)
Not enough class time	20.0% (67)
Generally inappropriate for students	6.0% (20)
Inappropriate equipment for physically handicapped	6.0% (20)
Students are not interested	3.0% (09)
Need teacher training	1.5% (06)
Problems with administrators	1.5% (05)
Maintenance problems	1.0% (04)

Table XI.

Insert Table XI about here.

Many suggestions are stated with a low frequency (1-3%) but the only major ones are related to improvement and classification of software (about 50%). Thirty-nine percent of teachers (78) answered the question.

In summary, a positive attitude was revealed by teachers supplying data. Samples were provided of the types of computer instruction with most special needs groups. Teachers indicated they had good access to computers but they were only using computers about two hours per week with each student.

A wide variety of programs are being used and all types of uses, as suggested in the questionnaires, were selected and considered basically efficient. Drill and practice was the most common use. Computers in general were viewed as highly useful and beneficial to the students.

The most common brand of computer used was seen to be the "Apple" and the most common reason for this selection was the availability of software. Teachers were basically trained in the use of computers by self effort, general workshops, and through the help of colleagues. They felt the most important

Table XI

Suggestions on Research

Suggestions	% Frequency
Improve programs	30.0%
List of programs with updated sources	19.0%
More workshops/Inservice and special courses	9.0%
Attempt to reduce cost factor & more funding	7.5%
Classify programs for different ages	3.5%
Devices for those with poor motor control	3.5%
Improvement of games	3.5%
Information from Central office	3.5%
Preparation periods for learning to use computers	3.5%
Personal interviews with teachers and students	2.5%
Gauging amount of time needed	1.0%
General efficacy	1.0%
Handbook on "How to use computers"	1.0%
Improve teacher training	1.0%
Newsletter for teachers	1.0%
Programs for gifted	1.0%
Programs for lower achievers in regular classroom	1.0%

need in further research was program improvement. Data has been generated relating to samples of special needs students, the times they use computers and the possible benefits for them. Teachers have also revealed a great deal about their attitudes and practices. Comments about these findings, implications, and generalizations are found in Chapter V.

Chapter V

DISCUSSION & RECOMMENDATIONS

Introduction

One of the most interesting results of the study was the positive attitude of the respondents - superintendents and teachers alike. Not only were the percentages of those answering the questionnaires high, but many comments to the effect of the study being worthwhile and interesting, were received. Many superintendents indicated that the results of the study would be worthwhile to their school systems and many teachers requested a summary of the results of this research.

Computer Times

The access to computers seems to be quite adequate. Only 1.5% (3) of the teachers said they had no access and 68.5% (137) said they had a computer in their classroom. It was indicated by 72.5% (145) of the teachers that they could access computers either "daily", "anytime" or "as required".

However, the actual use of computers seems to contradict the ease of access. The range of computer hours per week was from 1.2 to 2.4, with an overall average 1.9 hours.

The literature does not address the number of hours that computers can profitably be used with special needs students. Efficacy studies concentrate mainly on differences between variables other than time, eg. the relationship between student achievement and the use of CAI. Thus, this seems to be a matter for further study, although the two hours per week discovered in the present study seems to be an under utilization of present resources.

The teachers' perceived use of programs and their effectiveness, as shown in Table IV, again appears to be in contradiction with the number of hours usage per week. Fifty percent or more of the teachers found software useful in all the categories, i.e. for drill and practice, improving motivation and self esteem, games, general reward and word processing. Even more significant, when teachers had to place a scale value showing effectiveness under each category, the moderate to high rating was consistent overall at 90%. Furthermore, 90% of the teachers indicated that computers were generally useful for teaching (Question C-3); 58% said that students learned more and better (Question C-4); 91% stated that students gained much satisfaction from using computers (Question C-5). These positive reactions seem to be related to a comment made by Lieber & Semmel (1985) that students

and teachers were shown to have an 80% positive reaction to being involved in a computer project.

All of these positive reactions to software use would lead to the conclusion that the number of hours used per week should be greater than two.

Use of Programs

Table IV indicates that teachers found programs useful for drill and practice in 25% of the reported cases; useful for improving motivation and self esteem in 18% of cases; useful for games in 17% of cases; useful for general reward in 15% of cases; useful for word processing in 15% of cases; and useful for computer literacy in 10% of cases. Based on the literature of Mokrus & Russel (1986), Semmel & Lieber (1986), Manion (1986), Lieber & Semmel (1985), drill and practice is the most common use of programs. The above researchers mention use for improvement of motivation and self-esteem and use for games, as being next in importance although no specific percentages appear to be available. Word processing seems to be a skill taught to increasing numbers of special needs students. Mokrus & Russel (1986), for example, stated that 27% of the teachers they interviewed were using a word processor to teach students. General reward is not mentioned specifically as a goal of computer use and computer literacy, although mentioned, is either

taken for granted or of a low priority.

When the teachers were asked to actually name the programs they were using, 289 were listed. (See Appendix D). The use of these programs showed a pattern similar to that found in Table IV. Drill and practice received a high frequency of response, improving motivation and self esteem followed, games was next and word processing was mentioned more often than general reward or computer literacy.

Of the 289 programs listed by far the greatest number were only indicated by 1% of teachers. Programs from MECC, Millikin, Sticky Bear Series, and Fay Series were exceptions to this appearing with a frequency of about 10%. This uncoordinated use of programs, (i.e. where many people make decisions without consultation), seems to be well documented in the literature (Horn & Finn 1983, Bennett 1985, Sitko 1985). Furthermore, inappropriate programs was a problem mentioned in 40% of the responses of Table XI (Difficulties in Using Computers). Of teachers giving suggestions on future research direction, 50% indicated improving programs should be a priority. Twenty-eight percent of teachers mentioned available software as reasons for choosing a brand of computer. All of this proves that selection of software is a major problem indeed and one that requires further research.

Efficacy Question

Much attention has been paid to the question of efficacy in the literature review section - (eg. Lieber & Semmel (1985). Teachers in this study were asked how useful the computers were for teaching purposes, whether the students "learn more and better" and whether the students gain satisfaction from the use of computers.

Ninety per cent of teachers indicated that computers were moderately to very effective in teaching and no reasons were given for computers not being useful in teaching. Some of the outstanding reasons for using computers were motivation, reward and reinforcement, drill and practice, individualization, and providing new experiences.

Fifty-eight percent of the teachers stated that they perceived students learned "more and better" with the use of computers. The positive responses were related to reinforcement, motivation, enjoyment and a new approach.

Thirty-six per cent of teachers were not sure if students learned "more and better". The majority of this group stated "more and better" learning cannot be measured. This seems tied to the statistical efficacy question mentioned in the literature review - for example Lieber & Semmel (1985 & 1986). Empirical

research has often proved equivocal and perhaps teachers feel that empirical research is necessary to defend instructional techniques before proceeding further.

The overwhelming majority of teachers (97%) indicated that students gain much satisfaction from the use of computers. Their reasons were enjoyment, motivation, reward, novelty, and immediate feedback. The only significant negative comment was that satisfaction depends upon the individual.

In summary, most of the teachers see a "practical" efficacy even if there is not a lot of empirical evidence to support the use of computers. They will probably continue to use computers and may well discover new programs and techniques even without a strong empirical base.

Teachers' Feelings About Computers

Moderate to high comfort feelings with computers were indicated by 91% of the respondents. The most common reasons stated were that computers are easy to use, followed by the statement that computers make things fun. In spite of the fact that most teachers are comfortable with computers, 17% of the questionnaires contained at least one comment indicating that teachers did not know how to use computers or needed instruction.

This latter statement seems to underline the need for computer training. The highest frequency of

of responses indicated that teachers were self taught (32%) or received help from colleagues (25%). A moderately high number participated in some form of general workshops (25%) and very few took college/ university courses (8%) or special education inservices (7%).

Mokrus & Russel (1986) report that in their study, about 66% of teachers had taken general workshops, and the same number had attended courses, although only 11% took courses related to special education and computers. Percentages for the self taught categories and help from colleagues category were not stated. Mokrus & Russel (1986) found the following problems to be stated by about 10% of the teachers:

1. Inappropriate software or lack of same.
2. Lack of computers.
3. Not enough class time.
4. Student attitudes.

When teachers, in this study, were asked why they had trouble using computers, a large majority indicated inappropriate programs (40%); a moderate number stated that there was not enough class time (20%); and that computers were too expensive (21%). Only a very small number indicated that increased training was needed.

Implications & Recommendations

First of all, it appears that the question of efficacy will never be completely settled. Empirical research will probably continue to go on and teachers and researchers will proceed to develop programs and put them into practice. There is undoubtedly need for both points of view - practical and empirical.

Teachers, in this study, felt positive about the use of computers with special needs students. This was true over all categories of students. They also felt students learn from computers and enjoy using them. For the most part teachers enjoyed the computers themselves. This suggests that teachers should be encouraged to use computers and perhaps more money should be budgeted by school administrators for computer hardware and software acquisition. Research costs need not be great if local workshops of a "hands on" nature, specifically for teachers, are conducted on a regular basis.

There was some sort of contradiction implied in the relationship between positive attitude about computers and actual use. Use of computers in hours is not high for any group of students. Since the framework for computer use is available - i.e. access and a positive attitude are present - some incentives must be needed to cause teachers to proceed with implementation.

Perhaps some help in scheduling is need and perhaps just positive recognition of a "good job" by administrators. Supplying teachers with comments on developments outside their jurisdictions and making them aware of research, may also make them feel they are part of something important.

The low incidence of use might also be related to a lack of confidence in computer software available. It might be speculated that teachers are employing drill and practice materials, or for that matter, any materials with which they feel comfortable, and then relying on traditional instruction. Thus, perhaps the number of hours spent with computers would increase in direct proportion to an increase in the quality of programs.

The fact that many teachers are self taught or get help from colleagues indicates that a poor system of training has gone on or is still causing a problem. It is implied that computer use may be suffering because of this factor. Training in cognitive development of special needs groups is certainly available. This training needs to be linked to a study of cognitive processes which ensue when a student is working with a computer.

The large number of software programs in use and the lack of duplication in their use among teachers implies some sort of problem. There is

either lack of communication or an attempt to find good software by trial and error. There is no reason why teachers cannot pass on names of good computer programs and comments about them. They could be given inservice time to do this. Also, school administrators at various levels could maintain a data book including actual copies of programs to forward to schools as requested.

The brand of computers used - predominantly "Apple" - implies that the software selection will have to be geared toward this product. It also imples that workshops could be concentrated on the use of these machines.

Limitations

As indicated previously, the research has been geared to school-age children in the public and separate systems. Undoubtedly, research with adults having special needs who are in various settings would lead to additional worthwhile data on computers. As well, there may be school-age children in settings such as hospitals where computers are used to improve adjustment to the environment.

Some variables which teachers might feel would affect the use of computers were not explored. For example, no questions were asked about the sex, age of the students or any about complicating home factors,

such as ESL problems.

Although physically disabled and sight and hearing impaired students were included in the survey, inquiries were not made about the specific hardware they need to access the computers. This could constitute another study.

The size of the sample could have been a limiting factor on the results. Forty-eight percent of the teachers did not complete a questionnaire. It can only be speculated as to whether their answers would have followed the same pattern. As well, this was a survey based on one province (Alberta) and it is possible other provinces' educational climates might change the nature of the responses.

Reliability and Validity

Wiersma (1980) defines reliability as consistency of an instrument in measuring what it measured. He defines validity as an instrument for measuring what it is supposed to measure. Since the questionnaire in this study is indeed an instrument, some consideration of these factors has to be included.

The fact that this was a questionnaire and not a test, has a bearing on the concept of reliability. In a test and re-test situation, reliable instruments would show very similar results. A questionnaire would allow some tolerance especially with the use of open

ended questions. It is noteworthy that some questions, for example C-3, C-4, C-5, produced some overlap - i.e. consistency - in the answers to open-ended questions. Some results of the present survey - for example the use of software, the staff development and the problems using computers - were very similar to those noted by Mokrus & Russel (1986). It is also significant that their study did not mention reliability.

Validity of this instrument might well be based on the steps described by Wiersma (1980) in constructing a satisfactory questionnaire.

1. A research problem was formulated and questions were related to it.
2. Both open ended and forced-choice items were used.
3. Some items were based on previous questionnaires (Mokrus & Russel 1986). Advice was solicited on organization and a construction of all items and a pilot-run of the items was made.
4. Cover letters were carefully prepared.
5. Plans were made for dealing with non-responses.
6. The returns were scrutinized to see that they covered a wide sample.

Future Research

Many unanswered questions appear to result from this study. In summary form they are as follows:

1. How can empirical research to explore the efficacy of CAI with special needs groups avoid the problem of equivocal results? Based on this study, and the literature review, it appears that research based on a single subject designs may be fruitful, because it reduces the number of variables to be studied at one time.

2. Why are teachers not using computers more hours? The answer may still lie in their attitudes and a lack of training they do not care to admit. It may also lie in school timetabling which would involve administrative investigations.

3. How can teacher training in the use of computers be improved? Perhaps some sort of standard training needs to be developed.

4. What is the most useful task to which computers can be assigned from the student's point of view? How indeed, can utility for the student be measured?

The student, for example, enjoys games, but is this useful?

5. How can cost be dealt with reasonably? Both hardware and software are expensive and the optimum expenditure per student depends on utility which in itself is a question.
6. How can programs be improved and classified? This is a question that occurs over and over again throughout the literature review and the questionnaire. At the very least, information about programs must be shared and some one must take responsibility for validating the programs.

Conclusion

Interest in the problem of computer use had been demonstrated from many points of view. Empirical research has often been equivocal and cannot be used without caution. Observational studies of research and surveys of teachers, indicate a rapidly developing field and a very positive attitude on the part of teachers and many researchers. There are still many problems to be solved. Based on the present study, the outlook is positive but there is still much to learn on how computers can be used most effectively with special needs groups.

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APPENDIX A

Results of Pilot Study 87

APPENDIX A

Number of math questions completed per minute.

Computer vs pencil and paper conditions.

Sample 1

Subject	Computer	Paper & Pencil
1	12.1	12.3
2	7.5	10.1
3	20.3	25.6
4	20.8	26.1
5	6.3	4.5
6	8.8	12.2
7	12.3	15.7
	$\bar{x}$ = 12.59	$\bar{x}$ = 15.14

Sample 2

Subject	Computer	Paper & Pencil
1	28.6	18.9
2	40.0	31.9
3	28.2	18.8
4	40.1	35.3
5	35.8	21.2
6	7.2	8.1
7	15.4	8.4
	$\bar{x}$ = 27.9	$\bar{x}$ = 21.37

Accuracy 98.1% under CAI
98.3% under paper & pencil

APPENDIX B

Teacher Questionnaire 89

APPENDIX B

Teacher Questionnaire

Section "A"

1. Are you in a system of __ 200 or more teachers.
   __ less than 200 teachers.
2. Do you and/or your students have access to a computer in the school? __ Yes
   __ No
3. Do you have a computer in your classroom?
   __ Yes
   __ No
   (If you answer "No" to 2 & 3, go to Section D.)
4. What type of computer(s) are used?
   _____
5. Why was this type of computer(s) selected?
6. How many do you have access to? _____
7. How often? _____

Section "B"

1. Are your students classified as having any or all of the following handicaps? (Check off please)
   - A. __ Mental retardation
     - __ (a) trainable
     - __ (b) educable
     - __ (c) severely/profoundly
   - B. __ Learning disabled
   - C. __ Autism
   - D. __ Emotional disturbance
   - E. __ Physical disabilities
     - __ (a) cerebral palsy
     - __ (b) paralysis
     - __ (c) other
   - F. __ Deaf or hearing impaired
   - G. __ Blind or visually impaired
   - H. __ Multiple handicaps

2. Please place an "X" beside the category of handicapped students who use the computer(s), and how much time per day.

		Hours per Week
A.	__ Mental retardation	_____
	__ (a) trainable	_____
	__ (b) educable	_____
B.	__ Learning disabled	_____
C.	__ Autism	_____
D.	__ Emotional disturbance	_____
E.	__ Physical disabilities	_____
	__ (a) cerebral palsy	_____
	__ (b) paralysis	_____
	__ (c) other	_____
F.	__ Deaf or hearing impaired	_____
G.	__ Blind or visually impaired	_____

3. For what purpose are the programs being used for students mentioned in questions 1 and 2 (check below) and how effective.

		Effective Ineffective (please circle)				
A.	__ Drill and practice.	1	2	3	4	5
B.	__ Improve motivation and self esteem.	1	2	3	4	5
C.	__ Games	1	2	3	4	5
D.	__ General reward	1	2	3	4	5
E.	__ Computer literacy	1	2	3	4	5
F.	__ Word processing	1	2	3	4	5
G.	__ Other (please specify)	1	2	3	4	5

4. Please make a list of the names of programs you are using with handicpped students.

Name of Program	Use (Indicate A-G above)

Section "C"

1. What type of computer training have you had?

   A. ___ Self taught.
   B. ___ Workshops sponsored by school administration.
   C. ___ Workshops on inservice, expecially for special education teachers.
   D. ___ University or college courses.
   E. ___ Help from colleagues.
   F. ___ Other. (please specify)

2. Do you feel comfortable or uncomfortable about the use of computers? Why? Please use 5 point scale.

   Comfortable Uncomfortable

   1 2 3 4 5

3. Do they help you teach? Please use 5 point scale.

   Effective Ineffective

   1 2 3 4 5

   How?

4. Do the students learn more/better? ___ Yes ___ No ___ Not sure

   Please explain answer.

5. Do you feel the students derive:
   ___ much satisfaction from them.
   ___ little satisfaction from them.
   Please explain your answer.

Section "D"

1. What difficulties have you (or would you) encounter when using computers?

   A. ___ Inappropriate programs.
   B. ___ Inappropriate equipment for physically handicapped.
   C. ___ Not considered useful for the students I teach.
   D. ___ Not enough class time for computer use.
   E. ___ Student attitudes (students aren't interested in using computers).
   F. ___ Lack of support and or resistance by administrators.
   G. ___ Too expensive
   H. ___ Other (please specify)

Please make any suggestions you feel would be useful in furthering research relating to the use of computers with the handicapped.

In order that I may account for the percentage of responses, please fill in the name of your school. It will not be reported in the research.

_____

APPENDIX C

1. Superintendent's Letter 94

2. Principal's Letter. 97

3. Teacher's Letter. 98

APPENDIX C-1

SUPERINTENDENT'S LETTER

I am currently doing research on the use of computers with special needs students and writing a thesis on this topic under the supervision of Dr. Linda McDonald, Department of Educational Psychology, University of Alberta. As a part of my research I am attempting to gather information from special education teachers province wide regarding the use of computers in the classroom and I am soliciting the help of Superintendents such as yourself. A copy of the questionnaire I am using is enclosed for your perusal.

I believe it would be to the advantage of all school systems to have information such as that I am accumulating. First of all, almost no research on the use of computers with special needs children has been done in Canada, although a relatively large number of studies has been done in the United States. Interestingly, much of the research which attempts to empirically demonstrate the effectiveness of computers with special populations, has yielded inconclusive results largely due to a difficulty in controlling the many variables involved.

Computers are expensive and in this time of fiscal

restraint, it is necessary to know what value they have and how they are being used. Nevertheless, this use of computers is still reported as doubling and tripling. I am therefore interested in a fresh approach used by a few reseachers, involving a survey. Hopefully, by sending a questionnaire to Alberta teachers, new and valuable information may be made available. The information will undoubtedly have implications for budgeting and curriculum development.

Therefore, it would be much appreciated if you would take the following steps.

1. Read over the enclosed questionnaire. With your permission, I would like to contact Principals in your jurisdiction who are in charge of schools educating special needs pupils. These pupils would be defined as those who would be eligible for special education funding. I would then ask these Principals to identify teachers who are directly responsible for the education of the noted pupils. Again assuming your permission and that of the Principals, I would forward the questionnaire to teachers for completion.

2. Please respond by filling in the form at the bottom of the page (or referring it to your designate). If you feel the study is not beneficial to your system please check the appropriate box.

3. Return your response in the stamped self addressed envelope.

Feel free to comment or ask any questions about the research. Please note that I will automatically make compiled questionnaire data available to you on request and also a summary of related research literature. I must, however, protect the anonymity of individual teachers.

Thanking you in advance.

School Jurisdiction: _____

Phone number: _____

Schools in this system which would house special needs programs:

School Name/Address	Principal/Phone No.
_____	_____
_____	_____
_____	_____
_____	_____

___ I do not feel my system will benefit from this
___ study.

Superintendent/Designate _____
(signature)

APPENDIX C-2

PRINCIPAL'S LETTER

Dear Principal:

As a part of my Master's Thesis, I am attempting to gather information from teachers on the use of microcomputers with special needs students. There is a large information gap in Canada as to what use is being made of computers by students who have handicaps, if they are not using them - why not, and how teachers feel about using computers. I have contacted your Superintendent and have his/her permission to survey teachers in the district. Please provide the instructor who is primarily responsible for educating any students eligible for special education funding, with the enclosed questionnaire and the self addressed envelope. All individual responses will be anonymous. Summary results will be available upon request.

APPENDIX C-3

TEACHER'S LETTER

Dear Colleague:

I am working on a Master's Degree in Special Education and, as a project for my thesis, I am researching the use of computers with special needs children. There is almost no information available in Canada regarding the use or non use of computers with this group. Therefore, I am asking you to fill in the enclosed questionnaire within the next week and return it to me in the enclosed envelope. Your Superintendant and Principal have been contacted on this project and they have approved it. Your responses will remain completely anonymous. Summary results will be available on request.

Thank you for your help.

APPENDIX D

NAMES OF PROGRAMS AND USE

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Names of Programs & Use

Legend: Pub - Publisher
G - Games
Gen - General
GR - General Reward
D&P - Drill & Practice
CL -Computer Literacy
IM - Improve Motivation
WP - Word Processing

	Number of Teachers Using							
	Pub	Gen	D&P	IM	G	GR	CL	WP
Academic Occupation		1						
Academic Skill Builder		1						
Addition Logician	MECC	4	3					
Albert Access			1	1	1	1	1	
Alien Addition		1	2	2	1			
Alligator Math			1	1				
Alligator Mix		2						
Alphabet Circus	DLM	3						
Alphabet Zoo			3	3	1			
Alphabots		1						
Amazing Mouse		1						
Animal Photo Fun	DLM	1						
Anti Aircraft					1			
Apple Works		5	2	4		3	5	18
Apple Wuzzle	MECC	1						
Arithmetic Critters	MECC	2	6	2	2	1	1	
At the Park	MECC	1						

	Pub	Gen	D&P	IM	G	GR	CL	WP
At the Zoo	MECC	1						
Bank Street Writer		10	2	5		1	1	17
Betabots		1						
Braille Edit		1						
Bumble Plot		1	1					
Calendar Skills			1					
Catch A Cake		1						
Caterpillar		2	1	1		1	1	
Certificate Maker		1				1	1	
Charlie Brown's ABCs		1						
Charlie Brown's 123			2	1	1			
Challenge Math			1	1				
Circus Math	MECC	6	10	5	5		2	
Clock Works	MECC	6	12	3	1			
Color Tones (Motor Training)		1						
Companion Kitchen	DLM	1						
Comprehension Power	Milli-kin	1						
Concentration			1					
Contractions			1					
Contraction Action	MECC	2	3		1		1	
Count and Add		2						
Counting Critters	MECC	3	7	1	1			
Create With Garfield			1	1	3			
Cross County Canada		1	2	5	1	1		

	Pub	Gen	D&P	IM	G	GR	CL	WP
Crossword Magic			1	1	1			
Crypto Cube		1	1					
Decimal Dungeon		1						
Dispatcher		1						
Double Feature		1						
Dragon Mix		1						
Drama and Oral Reading				1				
Early Addition	MECC	6	4	1	1		1	
Early Discoveries		1						
Early Games	Spring board		2	1				
Early Games for Young Children	MECC	1	3	1	2			
Easy as ABC	Spring board							
Elementary Drill and Practice		1						
Elem. Language Arts V.2	MECC	2	1					
Elem. Language Arts V.5	MECC	7						
Elem. Language Arts V.11	MECC	8						
Elem. Language Arts V.12	MECC	6						
Elementary Math V. 1	MECC	8			1	1		
Elementary Math V. 2	MECC	8			1	1		
Elementary Math V. 5	MECC	7			1	1		
Elementary Math V. 7	MECC	7			1	1		
Elem. Pre-reading & Counting	MECC	12	1	1	1			
Elementary Social Studies	MECC	5	1					
Elementary Word Games	MECC	6	1					

	Pub	Gen	D&P	IM	G	GR	CL	WP
Ernie's Quest					1	1		
Explorer Meteor					1			
EZ Logo	MECC	4						
Face Maker		1	2	1	2	2		
Fast Facts		1	1	1				
Fay: That Math Woman	Dida-tech	2	5	3	2			
Fay: The Word Hunter	Dida-tech	1	1	1	1			
Fay's Word Rally	Dida-tech	4	6	1	2	1		
First Letter Fun	MECC	6	10	4				
First R		1						
First Things First			1					
Foxatvision							1	
Fraction Action			1	1				
Fraction Factory			1					
Fraction Munchers	MECC	6	2	1				
Fraction Tutor			1	1				
Fred Writer		3		1				3
Frog Disection			1	1	1			
Frog Jump			1	1				
Friendly Computer	MECC	10	2	3	1	1	5	
Fun From A to Z		7	7	3	1	1		
Game Show					1	1		
Galaxy Math		1						
Gertrude's Secrets	Sun-burst	3	1	1				

	Pub	Gen	D&P	IM	G	GR	CL	WP
Gertrude's Puzzles	Sun-burst	3	1	1				
Getting Ready to Add		1	1	1				
Getting Ready to Read		1	1	1				
Gnees Not Gnees	Sun-burst	1						
Golf		2		1	1	1		
Grabit Factory		1						
Grammar Examiner			1	2	1	1		
Grammar Gremlins	David-son		1	2	1	1		
Growing Fractions			1		1			
Hang Man		2						
Health Ways (simulation)		1						
Hey Diddle Diddle			1	1				
Hinky Pinky		1						
Home Word		1						
Initial Consonants		2	3	1				
Instant Zoo	CTW	2						
Interaction Games	Don Johnston	1						
Introduction to Counting		1						
Introduction to Fractions		1						
Jenny's Journeys	MECC		5	1		1		
Juggles Rainbow		1						
Jungle Rescue				1				
Kermit's Story Maker			2	2	1	1	1	
Keyboard Cadet								1

	Pub	Gen	D&P	IM	G	GR	CL	WP
Keys to Computer-garden	Scholastic	1						
Kid's Corner			1	1		1		
Kids on Keys		2	1	1				
Kidwriter		1	2	4			3	5
Kinder Camp		1	1	2				1
Kinder Concepts -Math			1	1		1		
Kinder Concepts -Reading			1	1		1		
Kinder Read		1						
Kittens, Kids and a Frog		1						
Laser Chaser		1	1					
Learning About Numbers		2	2	2	1			
Learning Line		2						
Lion Workshop		1			1			
Lemonade					1			
Letters and First Words			2	1				
Lucky's Magic Hat		1						
Magic Slate		2	1	4	1	1	1	9
Magic Spells	Learning Co.	5	5	3		2		
Magic Window		1						
Make A Match			3	2		1		
Math	MECC	8	5	1	1			
Math Blaster	David-son		6	3		3		
Math Facts	DLM	1	2		1			
Math Activities Courseware	Houghton Mifflin	3						

	Pub	Gen	D&P	IM	G	GR	CL	WP
Math Activities Courseware 3	Houghton Mifflin		2					
Math Activities Courseware 5	Houghton Mifflin		1					
Math Activities Courseware 6	Houghton Mifflin		4					
Math Facts	DLM	1	2		1			
Math Basic Skills			1	1	1	1		
Math Rabbit	Learning Co.		1			1		
Math Voyager		2	2	1	1	1		
Master Spell		2	2	1				
Master Type			1					
Mathamatics Level A	SRA	1						
Mathamatics Level B	SRA	1						
Memory Castles		1	1					
Meteor Multiplication		2	2	1	1			
Micro Soft Classification Games		1						
Microzine		1	1	1				
Milliken Math Addition	Milliken	13	13	3		1		
Milliken Math Division	Milliken	10	9	7		1		
Milliken Math Multiplcation	Milliken	11	9	5		1		
Milliken Math Subtraction	Milliken	11	10	5		1		
Mind Puzzel		1						
Minus Mission	DLM	1	1	1				
Missing Links			1					
Mix & Match	CTW			2	1	1		
Money Works	MECC	8	3	2				

	Pub	Gen	D&P	IM	G	GR	CL	WP
Monkey Math		1	1	1				
Monkey News		1						
Mop Town		1						
Moon Patrol					1			
Motor Training Games	DLM	1	1					
Montanna Reading Program		2						
Mouse Paint		1			1	1		
Multiplication Puzzles	MECC	7	8	1	3	1		
Muppets on Stage			1		1			
Multiscribe		1						
Nouns Pronouns	Hart-ley	1						
Number Farm	DLM	3	2	1				
Number Munchers	MECC	5	10	3	2	2		
Number Readiness	Milli-kin		3					
Odel Lake				1	1	1		
On the Farm	MECC		1	2				
Operation Math Mind		1						
Oregon Trail		2	2	2	1			
Our Weird and Wacky World		1						
Pac Man					2			
Paint With Words	MECC	6	7	2	3	2	1	1
Paper Clip			1					
Path Tactics			1	1	2	1		
Peter Rabbit			1	1				

	Pub	Gen	D&P	IM	G	GR	CL	WP
Pollard Meadows		1						
Phonics Time Blends & Digraphs	MECC	2	4	1				
Phonics Time Vowels	MECC	2	3					
Pop R Spell	Milli-kin	1						
Pre-Reading Skills	MECC	3	5	3	1			
Pre-Reading & Counting	MECC	3	5	3	1			
Print Shop	MECC	10	2	5	1	3	1	2
Print Shop Graphics Library	MECC	2						
Prefixes and Suffixes	MECC	4						
Prefix Power			2	2				
Print Out	MECC	4		2				
Puzzler			1	1		1		
Puzzles & Posters		3						
Quiz Whiz		1						
Quotient Quest	MECC	8	10	3	3	2		
Rainbow Jiggle		1						
Raise the Flags			1					
Random House Galaxy		1						
Raster Blaster		1						
Read & Spell			1					
Read for Information		1						
Read for Meaning		5						
Reader's Workshop				1				
Reading Machine		1						

	Pub	Gen	D&P	IM	G	GR	CL	WP
Rhyme Land			1					
Right of Way		1	3	1	1			
Right Turn		1						
Rocky's Boots	Sun-Burst	1						
Sea Battle		1						
Selling Apples	MECC	2	2	2	1	1		
Shape & Color Rodeo	DLM	2						
Showtime		1						
Sight Vocabulary			1					
Skyfox		1						
Snoopy's Reading Machine			1	1				
Sound Track					1			
Space Subtraction	MECC	8	10	3	3	3	1	
Special Needs Math		2	3					
Special Needs Spelling	MECC		3	2	3	1		
Specific Skills Series			1					
Speedreader	David-son		2	1		1		
Spelling V. 1 & 2	MECC	8	5	2		1		
Speedway Math	MECC	5	10	2	1	1		
Spellcopter		2	4	4	2	3		
Spellograph		1	1					
Spelling Strategy		1						
Spelling System			1	1				
Spell It	David-son	2	4	4	4	1	4	

	Pub	Gen	D&P	IM	G	GR	CL	WP
Spider Math		1						
SRA Math Assistant	SRA	3						
Starcruiser		1						
Story Machine		1		1				
Story Maker		1		2		1		
Story Tree		1	1	1				
Sticky Bears ABC		9	6	4	5	3	2	
Sticky Bears Numbers		7	6	4	3	1		
Sticky Bears Opposites		6	4	4	2	1	1	
Sticky Bears Shapes		4	9	7	2	2		
Sticky Bears Typing		4						
Subtraction Puzzles	MECC	2	3	2	1	1		
Super Key		4	2					3
Super Text			1	1				
Sweet Shoppe		1						
Switch & See		1						
Tax Man					1	1		
Teddy & Iggy	Sun-burst	1						
Teddy's Playground	Sun-burst		1	1		1		
Terrapin Logo		2						
Think Quick		1						
Those Amazing Reading Machines		2	2			1		
Three Bears			2	1				
Tic Tac Toe Show		3		1				

	Pub	Gen	D&P	IM	G	GR	CL	WP
Tiger Tails	Sun-burst		1					
Time Capsule		1						
Tip & Flip	Sun-burst	1						
Transylvania		1						
Treasury Island		1						
Type to Learn				1				
Typing Tutor			2					
Versa Brailler Tutorial		1						
Visual Discrimination Shapes			1					
Vowels I		1	1					
Vowels II		1	1					
What's First What's Next			1	1				
Windham Classics		1						
Winnie the Pooh Word Memory Game		1						
Wizard Magic Spelling		3						
Word Attack	David-son		2	3		1		
Word Machine		1						
Word Munchers	MECC	8	5	2	1	1		
Word Invasion		1						
Word Man		1						
Word Processor	Milli-kin	1						
Word Quest			1	1				
Words at Work - Suffix Sense		1						
Word Search			1		1			

	Pub	Gen	D&P	IM	G	GR	CL	WP
Word Spinner		2	2	1				
Word Star								1
Word State		1						
Word Wizard	MECC	3	8	3		1		
Working with Antonyms			2					
Working with Synonyms			2					
Write One		1						
Writer Rabbit			1	1	1	1		4